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## DESCRIPTION

## BASE STATION APPARATUS AND TRANSMISSION METHOD

## 5 Technical Field

The present invention relates to a base station apparatus and a transmission method. More particularly, the present invention relates to a base station apparatus and transmission method using an automatic repeat request  
10 system to recover a loss of a packet on a radio channel by retransmission of the packet.

## Background Art

As shown in FIG.1, mobile communication system 10  
15 is comprised of mobile terminals 11, base station apparatuses 12, radio network control apparatuses 13 that control a plurality of base station apparatuses 12, and core network 14 that performs position management, call connection control and the like for the mobile terminals  
20 11.

HSDPA (High Speed Downlink Packet Access) techniques being standardized in 3GPP (3rd Generation Partnership Project) are applied to wireless transmission between mobile terminals 11 and base station apparatuses 12.

25 HSDPA is new techniques whose standardization has proceeded in 3GPP, and achieves high-speed transmission on the downlink radio channel from base station apparatus

12 to mobile terminal 11 by applying an adaptive modulation system, hybrid ARQ (HARQ) system, fast selection of a communication destination user, and methods of changing transmission parameters adaptively corresponding to the  
5 status of the radio channel and the like to wireless interfaces.

Further, HSDPA is such a system that a plurality of mobile terminals 11 shares one radio channel to perform data transfer, and a best effort type communication form.  
10 More specifically, each mobile terminal 11 reports a channel state of the downlink radio channel to base station apparatus 12, and base station apparatus 12 performs scheduling of the transmission order of data to the plurality of mobile terminals 11, and transmits the data  
15 to mobile terminals 11.

FIG.2 illustrates a protocol configuration of user plane when HSDPA is applied. MAC-hs (Medium Access Control used for high speed) is to perform processing of the HARQ system, scheduling and the like, and installed  
20 in mobile terminals 11 and base station apparatuses 12. Further, an RLC (Radio Link Control) protocol that is a selective retransmission type of retransmission control protocol is installed higher than MAC-hs.

HS-DSCH/FP (High Speed Downlink Shared Channel Frame  
25 Protocol) is further installed for flow control between a MAC-hs processing section of base station apparatus 12 and an RLC processing section of radio network control

apparatus 13. The flow control controls the amount of packets transmitted and received between base station apparatus 12 and radio network control apparatus 13. More specifically, radio network control apparatus 13 reports  
5 to base station apparatus 12 a capacity request message setting the amount of packets to transmit, and base station apparatus 12 reports to radio network control apparatus 13 a capacity allocation message setting the amount of packets allowed to be transmitted. In addition, based  
10 on the use amount of the buffer of the node of the apparatus 12, base station apparatus 12 may report to radio network control apparatus 13 a capacity allocation message without receiving a capacity request message from radio network control apparatus 13, and control the amount of  
15 transmission packets from radio network control apparatus 13.

The operation in mobile communication system 10 will be described below with reference to FIG.3. FIG.3 is a sequence diagram illustrating the operation in mobile  
20 communication system 10.

When an HS-DSCH/FP processing section of base station apparatus 12 confirms that the amount of data stored in the buffer of the MAC-hs processing section does not exceed a threshold, the HS-DSCH/FP processing  
25 section transmits a capacity allocation message to permit transmission of AMD-PDU to radio network control apparatus 13 (step ST21).

Upon receiving the capacity allocation message, the RLC processing section of radio network control apparatus 13 transmits AMD-PDUs0~127 to base station apparatus 12 (step ST22).

5 AMD-PDUs0~127 transmitted from the RLC processing section of radio network control apparatus 13 are stored in the buffer in the MAC-hs processing section in base station apparatus 12. Then, according to the scheduling in the MAC-hs processing section, the AMD-PDUs stored  
10 in the buffer of base station apparatus 12 are sequentially transmitted to mobile terminal 11. At this point, it is assumed that AMD-PDU0 is discarded by error on the radio channel (step ST23).

Upon receiving next AMD-PDU1 (step ST24), an RLC  
15 processing section of mobile terminal 11 detects the discarding of AMD-PDU0 from the sequence number set in the AMD-PDU. Then, the RLC processing section of mobile terminal 11 transmits STATUS-PDU0 to request for retransmission of AMD-PDU0 to the RLC processing section  
20 of radio network control apparatus 13 (step ST25).

At the same time, mobile terminal 11 starts up Timer\_Status\_Prohibit to limit the transmission interval of STATUS-PDU. Upon receiving the STATUS-PDU0, the RLC processing section in radio network control apparatus  
25 13 increments VT(DAT) to "1" (VT(DAT)=1), and retransmits AMD-PDU0 to base station apparatus 12 (step ST26).

The AMD-PDU0 is stored in the buffer in the MAC-hs

processing section in base station apparatus 12 but is not immediately transmitted to mobile terminal 11, because not all of previously stored AMD-PDUs1~127 have not been transmitted yet. Base station apparatus 12  
5 transmits the AMD-PDUs1~127 stored in the buffer to the RLC processing section of mobile terminal 11 until the AMD-PDU0 retransmitted from the RLC processing section of radio network control apparatus 13 is transmitted to the RLC processing section of mobile terminal 11 (step  
10 ST27).

Since the AMD-PDU0 whose retransmission has been requested is not received when Timer\_Status\_Prohibit expires, the RLC processing section of mobile terminal 11 transmits STATUS-PDU1 to request again for  
15 retransmission of AMD-PDU0 to the RLC processing section of radio network control apparatus 13 (step ST28).

Upon receiving STATUS-PDU1, the RLC processing section in radio network control apparatus 13 increments VT(DAT) to "2" (VT(DAT)=2), and retransmits again  
20 AMD-PDU0 to base station apparatus 12 (step ST29).

However, AMD-PDU0 is stored in the buffer in the MAC-hs processing section in base station apparatus 12, but not transmitted immediately to mobile terminal 11 because all of AMD-PDUs1~127 stored previously are not  
25 transmitted yet. Base station apparatus 12 transmits the AMD-PDUs1~127 stored in the buffer to the RLC processing section of mobile terminal 11 until the AMD-PDU0

retransmitted from the RLC processing section of radio network control apparatus 13 is transmitted to the RLC processing section of mobile terminal 11 (step ST30).

5 Since AMD-PDU0 whose retransmission has been requested is not received when Timer\_Status\_Prohibit expires, the RLC processing section of mobile terminal 11 transmits STATUS-PDU2 to request again for retransmission of AMD-PDU0 to the RLC processing section of radio network control apparatus 13 (step ST31).

10 Subsequently, the operation of steps ST25 to ST30 is thus repeated. Whenever the RLC processing section of radio network control apparatus 13 receives a STATUS-PDU with a request for retransmission of the same AMD-PDU, i.e. AMD-PDU0, the RLC processing section  
15 increments VT(DAT), and when the value of VT(DAT) reaches MaxDAT, starts up process of resetting the RLC protocol to transmit a RESET-PDU to base station apparatus 12 (step ST32).

By this means, the RLC protocol in mobile terminal  
20 11 and radio network control apparatus 13 is initialized, and the data stored in the RLC processing section is all discarded. Further, when the RESET-PDU transmitted from the RLC processing of radio network control apparatus 13 does not immediately arrive at the RLC processing  
25 section of mobile terminal 11 by delay in the buffer in the MAC-hs, the RLC processing section of radio network control apparatus 13 retransmits the RESET-PDU every time

Timer\_RST expires (steps ST33 and ST34).

The RLC processing section of radio network control apparatus 13 increments VT(RST) whenever transmitting the RESET-PDU, and when a value of VT(RST) reaches MaxRST, judges as an error on the radio channel and reports the event to an RRC (Radio Resource Control) processing section. Then, the RRC processing section starts up the process of disconnecting the radio channel used by the mobile station 11.

10 In the case where transmission between the base station apparatus and mobile terminal is performed, for example, on a best-effort basis, many AMD-PDUs are stored in the buffer in the MAC-hs processing section of the base station apparatus when the transmission data rate decreases, and some AMD-PDU is discarded by an overflow of the buffer. Further, an AMD-PDU may be discarded by transmission error between the base station apparatus and mobile terminal. When an AMD-PDU is discarded, the discarded AMD-PDU is retransmitted between the RLC processing section of the radio network control apparatus and the RLC processing section of the mobile terminal. However, when many AMD-PDUs are stored in the buffer in the MAC-hs processing section, the retransmitted AMD-PDU needs to wait long in the buffer, and does not immediately arrive at the RLC processing section of the mobile terminal. Therefore, the RLC processing section of the radio network control apparatus repeats retransmission of the same

AMD-PDU, and there arises a problem of decrease in throughput.

Then, when the number of retransmissions reaches a predetermined threshold, the RLC processing section  
5 of the mobile terminal discards all the stored data, while the RLC processing section of the radio network control apparatus also discards all the stored data, and this gives another problem that the communication is disrupted.

10 Further, when the number of times the RESET message is transmitted from the RLC processing section of the radio network control apparatus reaches a predetermined threshold due to an increased number of retransmissions, the RRC processing section starts up the process of  
15 disconnecting the radio channel used by the mobile terminal in response to a report from the RLC processing section, the radio channel used by the mobile terminal is thereby disconnected, and another problem further occurs that the mobile terminal cannot receive the service  
20 being used by the terminal.

#### Disclosure of Invention

It is therefore an object of the present invention to provide a base station apparatus and transmission  
25 method for controlling the amount of transmission packet data requested for retransmission and stored in a buffer, thereby improving throughput and preventing disruption



of communication and channel disconnections.

When a communication terminal apparatus sends a retransmission request, the above-noted object is achieved by adjusting the amount of data multiplexed, between transmission packet data requested for retransmission and new transmission packet data not requested for retransmission based on reception quality information (CQI: Channel Quality of Indicator) of the communication terminal apparatus contained in a received signal, and storing data in a buffer accordingly.

#### Brief Description of Drawings

FIG.1 is a diagram illustrating an entire conventional communication system;

FIG.2 is a diagram of a conventional protocol configuration;

FIG.3 is a sequence diagram illustrating the operation in the conventional communication system;

FIG.4 is a block diagram illustrating a configuration of a base station apparatus according to Embodiment 1 of the invention;

FIG.5 is a block diagram illustrating a configuration of a mobile terminal apparatus according to Embodiment 1 of the invention;

FIG.6 is a block diagram illustrating a configuration of an HS-DSCH/FP processing section according to Embodiment 1 of the invention;

FIG.7 is a block diagram illustrating a configuration of an RLC processing section according to Embodiment 1 of the invention;

FIG.8 is a view showing a reference table indicating  
5 the relationship between CQI and the amount of receivable data according to Embodiment 1 of the invention;

FIG.9 is a diagram of a protocol configuration according to Embodiment 1 of the invention;

FIG.10 is a sequence diagram illustrating the  
10 operation in the communication system according to Embodiment 1 of the invention;

FIG.11 is a block diagram illustrating a configuration of an HS-DSCH/FP processing section according to Embodiment 2 of the invention;

FIG.12 is a block diagram illustrating a  
15 configuration of a base station apparatus according to Embodiment 3 of the invention; and

FIG.13 is a sequence diagram illustrating the  
operation in a communication system according to  
20 Embodiment 3 of the invention.

#### Best Mode for Carrying Out the Invention

Embodiments of the present invention will specifically be described below with reference to the  
25 accompanying drawings.

(Embodiment 1)

A configuration of base station apparatus 100 according to Embodiment 1 of the invention will be first described below with reference to FIG.4. FIG.4 is a block diagram illustrating the configuration of base station apparatus 100 according to Embodiment 1 of the invention.

MAC-hs processing section 109 is comprised of CQI extracting section 103, scheduler 104 and buffer 107.

Radio layer 1 processing section 102 performs radio signal processing on a received signal received in antenna 101 to output to CQI extracting section 103 and MAC-d (Medium Access Control used for dedicated) processing section 105. Radio layer 1 processing section 102 further performs radio signal processing on scheduling information input from scheduler 104 to transmit from antenna 101, while performing radio processing on high-speed packet communication data input from buffer 107 to transmit from antenna 101.

CQI extracting section 103 extracts a CQI that is reception quality information included in the received signal input from radio layer 1 processing section 102 to output to scheduler 104 and HS-DSCH/FP processing section 108. The CQI is the reception quality information of a communication terminal apparatus and transmitted from the communication terminal apparatus to base station apparatus. Scheduler 104 that is transmission means holds a reference table storing modulation scheme

information that associates the modulation scheme such as 16QAM with CQI, and another reference table storing coding rate information that associates the coding rate with CQI. Each of communication terminal apparatuses and  
5 base station apparatus has the same reference table storing the modulation scheme information and the same reference table storing the coding rate information. Then, scheduler 104 refers to the reference tables using the CQI input from CQI extracting section 103, thereby  
10 determines transmission parameters such as a modulation scheme and coding rate, and further determines a communication terminal apparatus to which packet data is transmitted on a predetermined time basis (generally, referred to as "scheduling"). Scheduler 104 outputs thus  
15 determined scheduling information of transmission parameters and the like to buffer 107 and radio layer 1 processing section 102.

MAC-d processing section 105 performs MAC-d processing on the received signal input from radio layer  
20 1 processing section 102 to output to RLC processing section 106. Further, MAC-d processing section 105 performs MAC-d processing on transmission packet data input from RLC processing section 106, while adding a MAC-d header, and outputs the packet to buffer 107. In  
25 addition, details of the MAC-d processing are described in 3GPP, TS25.321 Medium Access Control (MAC) protocol specification, V3.14.0.

RLC processing section 106 that is retransmission control means performs RLC processing on the received signal input from MAC-d processing section 105 to output to a radio network control (RNC) apparatus. Further, RLC processing section 106 has the function of performing retransmission control of data based on a selective retransmission type of retransmission control protocol, and performs the RLC processing in response to a retransmission request from a communication terminal apparatus contained in the received signal. In the RLC processing of the selective retransmission type of retransmission control protocol performed in RLC processing section 106, based on ACK or NACK (Negative ACKnowledgement) reported from the communication terminal apparatus, RLC processing section 106 selects packet data (transmission packet data to be retransmitted) reported as NACK from among transmitted packet data. Then, based on information of the amount of transmission packet data that is newly storable in buffer 107 where the information is input from HS-DSCH/FP processing section 108, RLC processing section 106 multiplexes the selected transmitted packet data and transmission packet data newly input from the radio network control (RNC) apparatus to output to MAC-d processing section 105 at a predetermined transfer rate.

Meanwhile, when a retransmission request is not transmitted from the mobile terminal apparatus, based

on the information of the amount of transmission packet data that is newly storable in buffer 107 input from HS-DSCH/FP processing section 108, the RLC processing section 106 multiplexes only the new transmission packet data to output to MAC-d processing section 105. In addition, details of RLC processing section 106 will be described later.

Buffer 107 that is storing means temporarily stores the transmission packet data input from MAC-d processing section 105, and outputs transmission packet data of timing and the amount of data corresponding to the result of scheduling in scheduling section 104 to radio layer 1 processing section 102. Further, buffer 107 is set for an upper limit threshold and lower limit threshold to compare with a amount of data stored of transmission packet data, and outputs a result of comparison between the amount of data stored and the upper limit threshold or between the amount of data stored and the lower limit threshold to HS-DSCH/FP processing section 108 as the amount of data stored information.

HS-DSCH/FP processing section 108 that is data amount control means extracts TFRI (Transport-format and Resource related Information) that is information on resource allocation from the CQI input from CQI extracting section 103, and detects the receivable data amount of the communication terminal apparatus. Further, HS-DSCH/FP processing section 108 outputs a message to

resume transmission or another message to halt transmission to RLC processing section 106, using the result of comparison of the amount of data stored with the upper limit threshold or lower limit threshold input  
5 from buffer 107. Furthermore, HS-DSCH/FP processing section 108 determines the amount of transmission packet data (multiplexing data amount) to newly store in buffer 107, from the amount of data stored information of transmission packet data stored in buffer 107 input from  
10 buffer 107 and the receivable data amount in the communication terminal apparatus, and outputs the determined amount of transmission packet data information to RLC processing section 106 together with the message to resume transmission. In addition, details of  
15 HS-DSCH/FP processing section 108 will be described later.

A configuration of communication terminal apparatus 200 according to Embodiment 1 of the invention will be described below with reference to FIG.5. FIG.5 is a block  
20 diagram illustrating the configuration of communication terminal apparatus 200 that is a communicating party of base station apparatus 100 according to Embodiment 1 of the invention.

Radio layer 1 processing section 202 performs radio  
25 signal processing on a received signal received in antenna 201 to output to MAC-hs processing section 203. Further, radio layer 1 processing section 202 performs radio signal

processing on a transmission signal including a CQI, retransmission request signal and the like input from MAC-d processing section 204 to transmit from antenna 201.

5           MAC-hs processing section 203 performs MAC-hs processing on the received signal input from radio layer 1 processing section 202. In other words, MAC-hs processing section 203 extracts the scheduling information received from the base station apparatus,  
10 and instructs MAC-d processing section 204 to transmit data according to the extracted scheduling information.

          MAC-d processing section 204 performs MAC-d processing on the received signal input from MAC-hs processing section 203 to output to RLC processing section  
15 205. Further, MAC-d processing section 204 performs MAC-d processing on the transmission signal input from RLC processing section 205, while adding a MAC-d header, and outputs the resultant to radio layer 1 processing section 202.

20           RLC processing section 205 has the function of controlling retransmission of data based on the retransmission control protocol, performs RLC processing on the received signal input from the MAC-d processing section, and judges whether or not the packet data  
25 requested for retransmission is received. Then, RLC processing section 205 outputs a retransmission request signal to MAC-d processing section 204 until the packet



data requested for retransmission arrives.

A configuration of HS-DSCH/FP processing section 108 will be described below with reference to FIG.6. FIG.6 is a block diagram illustrating the configuration  
5 of HS-DSCH/FP processing section 108.

CQI referring section 301 stores in a reference table the receivable data amount information (reception quality information) which associates CQI with a receivable data amount of the communication terminal apparatus and which  
10 is the same as that in the communication terminal apparatus. By referring to the reference table using the CQI input from CQI extracting section 103, CQI referring section 301 is able to recognize the receivable data amount (TFRI). Then, CQI referring section 301 outputs the recognized  
15 receivable data amount information to comparison control section 302.

When comparison control section 302 receives from buffer 107 the amount of data stored information indicating that the amount of data stored exceeds or equal  
20 to the upper limit threshold, comparison control section 302 outputs a capacity allocation message set for a value indicative of halting transmission to RLC processing section 106. Meanwhile, when comparison control section 302 receives from buffer 107 the amount of data stored  
25 information indicating that the amount of data stored (queue length) is less than or equal to the lower limit threshold, comparison control section 302 outputs a

capacity allocation message set for a value indicative of resuming transmission to RLC processing section 106. Then, when comparison control section 302 receives from buffer 107 the amount of data stored information  
5 indicating that the amount of data stored is less than or equal to the lower limit threshold, comparison control section 302 obtains the amount of transmission packet data to newly store in buffer 107 such that the amount of data stored in buffer 107 is less than or equal to  
10 the receivable data amount from the receivable data amount information input from CQI referring section 301. Comparison control section 302 outputs the obtained amount of transmission packet data information to RLC processing section 106 together with the capacity  
15 allocation message set for a value indicative of resuming transmission.

A configuration of RLC processing section 106 will be described below with reference to FIG.7. FIG.7 is a block diagram illustrating the configuration of RLC  
20 processing section 106.

Separating section 401 outputs NACK to buffer 402, when the received signal input from MAC-d processing section 105 contains NACK that is a retransmission request signal. Further, separating section 401 outputs signals  
25 except the retransmission request signal to radio network control (RNC) apparatus not shown in the figure.

Buffer 402 stores new transmission packet data input

from the radio network control (RNC) apparatus until a predetermined time elapses. When buffer 402 receives a report of NACK from separating section 401, buffer 402 selects transmission packet data reported as NACK from  
5 stored already-transmitted transmission packet data, as transmission packet data requested for retransmission, to output to multiplexing control section 403. Meanwhile, buffer 402 discards the stored transmission packet data when a predetermined time elapses without receiving a  
10 report of NACK from separating section 401.

Multiplexing control section 403 that is multiplexing means multiplexes the new transmission packet data input from the radio network control (RNC) apparatus and retransmission packet data requested for  
15 retransmission input from buffer 402 according to control of HS-DSCH/FP processing section 108. In other words, multiplexing control section 403 multiplexes preferentially transmission packet data requested for retransmission, and when the amount of data after  
20 multiplexing the transmission packet data requested for retransmission is less than the amount of transmission packet data instructed from HS-DSCH/FP processing section 108, multiplexes the new transmission packet data on the transmission packet data requested for retransmission.  
25 Meanwhile, when the communication terminal apparatus does not transmit a retransmission request, multiplexing control section 403 multiplexes only the new transmission

packet data by the amount of transmission packet data instructed from HS-DSCH/FP processing section 108. Then, multiplexing control section 403 outputs multiplexed transmission packet data to MAC-d processing section 105.

5           In addition, the transmission packet data requested for retransmission is preferentially multiplexed when multiplexing control section 403 performs multiplexing, but the invention is not limited to such a case. When a communication terminal apparatus requests transmission  
10 of new transmission packet data earlier, multiplexing control section 403 may multiplex the new transmission packet data preferentially, and thus, priorities of multiplexing can be determined arbitrarily to the new transmission packet data and transmission packet data  
15 requested for retransmission.

FIG.8 shows the reference table storing the receivable data amount information that associates CQI with the receivable data amount information.

From FIG.8, the receivable data amount is 100 bit/sec  
20 when the CQI is "1", the receivable data amount is 200 bit/sec when the CQI is "2", and the receivable data amount is 300 bit/sec when the CQI is "3". In addition, the relationship between the CQI and receivable data amount only needs that the base station apparatus and  
25 communication terminal apparatus store the same receivable data amount information, and can be changed arbitrarily corresponding to then propagation

environments or the like.

FIG.9 is a diagram of a protocol configuration of user plane in the communication system of the invention. FIG.9 differs from the conventional configuration in  
5 FIG.2 in the respect that MAC-d and RLC is provided in the base station apparatus.

Referring to FIG.10, described below is the operation in the communication system for performing communications using base station apparatus 100, mobile  
10 terminal apparatuses 200 and the like. FIG.10 is an operation sequence diagram illustrating the operation in the communication system for performing communications using base station apparatus 100, mobile terminal apparatuses 200 and the like. In addition, in FIG.10,  
15 buffer 107 and RLC processing section 106 in the base station apparatus are provided in the same base station apparatus 100.

First, when HS-DSCH/FP processing section 108 in base station apparatus 100 confirms that the amount of  
20 data stored in buffer 107 of MAC-hs processing section 109 does not exceed the set lower limit threshold (the number of AMD-PDUs is "0"), HS-DSCH/FP processing section 108 outputs a capacity allocation message to permit transmission of new AMD-PDU to RLC processing section  
25 106 (step ST701). The capacity allocation message is to report the number of AMD-PDUs permitted to transmit for each transmission period T on a predetermined radio

channel. In addition, it is assumed in FIG.9 that "4" is the maximum number of AMD-PDUs that can be transmitted within one transmission period T on the radio channel. However, the maximum number of AMD-PDUs that can be transmitted within one transmission period T is not limited to "4", and may be set at an arbitrary number.

RLC processing section 106 of base station apparatus 100 to which the number of AMD-PDUs allowed to be newly transmitted is reported outputs four AMD-PDUs, 0~3, to buffer 107 (step ST702). At this point, the amount of data stored in buffer 107 becomes equal to the upper limit threshold (the number of AMD-PDUs is "4"), and HS-DSCH/FP processing section 108 instructs RLC processing section 106 to halt transmission.

MAC-hs processing section 109 fetches AMD-PDUs 0~3 from buffer 107 to transmit to communication terminal apparatus 200 (step ST703).

At this point, AMD-PDU0 is discarded that is one of the four AMD-PDUs transmitted due to an error on the radio channel. In addition, in the case of HSDPA, the AMD-PDU targeted for discarding at this point is not saved even by performing retransmission by HARQ.

RLC processing section 205 in communication terminal apparatus 200 transmits STATUS-PDU0 set for a retransmission request for the discarded AMD-PDU0 to RLC processing section 106 in base station apparatus 100 (step ST704). However, at this point, RLC processing section

106 does not have permission to transmit a new AMD-PDU, and therefore, does not transmit AMD-PDU0 requested to retransmit.

Next, since the amount of data stored in buffer 107  
5 is less than or equal to the lower limit threshold, HS-DSCH/FP processing section 108 in base station apparatus 100 permits RLC processing section 106 to newly transmit two AMD-PDUs in consideration of the receivable data amount in communication terminal apparatus 200 (step  
10 ST705).

RLC processing section 106, the number of AMD-PDUs allowed to be newly transmitted is reported, outputs AMD-PDU0 requested for retransmission and new different AMD-PDU4 to buffer 107 (step ST706).

15 MAC-hs processing section 109 fetches AMD-PDU0 and AMD-PDU4 from buffer 107 to transmit to communication terminal apparatus 200 (step ST707). Thus, retransmission of AMD-PDU0 that is discarded on the radio channel is completed.

20 Referring to FIG. 9, described below is the case where the number of AMD-PDUs allowed to be newly transmitted determined in HS-DSCH/FP processing section 108 in base station apparatus 100 is different from the number of AMD-PDUs that the apparatus 100 was able to actually  
25 transmit on the radio channel.

When the amount of data stored in buffer 107 is less than or equal to the lower limit threshold, HS-DSCH/FP

processing section 108 in base station apparatus 100 permits RLC processing section 106 to newly transmit four AMD-PDUs in consideration of the receivable data amount in communication terminal apparatus 200 (step ST708).

- 5 At this point, the amount of data stored in buffer 107 exceeds or equal to the upper limit threshold (the number of AMD-PDUs is "4"), HS-DSCH/FP processing section 108 in base station apparatus 100 instructs RLC processing section 106 to halt transmission.

- 10 Next, RLC processing section 106, to which the number of AMD-PDUs allowed to be newly transmitted is reported, outputs to buffer 107 new AMD-PDUs 5~8 (step ST709).

- At this point, MAC-hs processing section 109 cannot transmit even one AMD-PDU due to an increase in the  
15 communication amount of other users, deterioration in radio channel state and the like, and stores four AMD-PDUs, 5~8, in buffer 107.

- Then, even when HS-DSCH/FP processing section 108 receives the CQI enabling permission of transmission of  
20 four AMD-PDUs from MAC-hs processing section 109, since buffer 107 already stores AMD-PDUs not less than the upper limit threshold indicative of AMD-PDUs allowed to be transmitted for a transmission period of the radio channel, HS-DSCH/FP processing section 108 outputs a message not  
25 to permit RLC processing section 106 to transmit new AMD-PDUs to RLC processing section 106 (step ST710).

MAC-hs processing section 109 fetches AMD-PDU 5~8



already stored in buffer 107 to transmit to communication terminal apparatus 200 (step ST711). By this means, all the AMD-PDUs stored in buffer 107 have been transmitted, and the number of AMD-PDUs stored in buffer 107 becomes  
5 less than or equal to the lower limit threshold. Then, the operation of steps ST701 to ST711 is repeated subsequently. In addition, the lower limit threshold and upper limit threshold for the number of AMD-PDUs in buffer 107 are not limited respectively to "0" and "4", and may  
10 be set arbitrarily.

Thus, according to Embodiment 1, the base station apparatus controls the number of AMD-PDUs stored in the buffer by the HS-DSCH/FP processing section, and, when an AMD-PDU that cannot be transmitted due to deterioration  
15 in radio channel state and so forth is stored in the buffer, limits the storage of new transmission packet data retransmission of which is not requested in the buffer, and preferentially stores transmission packet data requested for retransmission in the buffer, thereby  
20 reducing the number of retransmission requests and improving throughput, and preventing disruption of communication and channel disconnection.

Further, according to Embodiment 1, it is possible in a base station apparatus to control whether or not  
25 to newly store data requested for retransmission, so that the amount of data stored in the buffer can be controlled promptly. Further, according to Embodiment 1, also in

the case where retransmission is not requested, it is possible to control the amount of new transmission packet data stored in the buffer, thereby making it possible to prevent transmission packet data from being discarded  
5 from the buffer due to overflow when the transmission rate decreases due to deterioration in radio channel or the like.

(Embodiment 2)

10 FIG.11 is a block diagram illustrating a configuration of HS-DSCH/FP processing section 108 in a base station apparatus according to Embodiment 2 of the invention. In addition, configurations of the base station apparatus and communication terminal apparatus  
15 are the same as in FIGs. 4 and 5 except threshold information input to HS-DSCH/FP processing section 108, and descriptions thereof are omitted.

CQI referring section 802 stores in the reference table the same transmission data rate information  
20 (reception quality information) associating the CQI with the transmission data rate as that in the communication terminal apparatus. CQI referring section 801 refers to the reference table using the CQI input from CQI extracting section 103, and is thereby capable of detecting the  
25 transmission data rate (TFRI). Then, CQI referring section 801 outputs detected transmission data rate information to queuing delay calculating section 802.

Queuing delay calculating section 802 calculates queuing delay time from the transmission data rate information input from CQI referring section 801 and the amount of data stored information of transmission packet data in buffer 107 input from buffer 107. The queuing delay time is calculated by dividing the amount of data stored by the transmission data rate. Then, queuing delay calculating section 802 outputs the information of the calculated queuing delay time to comparison control section 803.

When comparison control section 803 receives from buffer 107 the amount of data stored information indicating that the amount of data stored exceeds or equal to the upper limit threshold, comparison control section 803 outputs a capacity allocation message set for a value indicative of halting transmission to RLC processing section 106. Meanwhile, when comparison control section 803 receives from buffer 107 the amount of data stored information indicating that the amount of data stored (queue length) is less than or equal to the lower limit threshold, comparison control section 803 outputs a capacity allocation message set for a value indicative of resuming transmission to RLC processing section 106. Then, using the queuing delay time information input from queuing delay calculating section 802, comparison control section 803 controls supply amounts to RLC processing section 106 of transmission packet data retransmission

of which is requested and new transmission packet data retransmission is not requested. The threshold to compare with the queuing delay time in comparison control section 803 is set at a value smaller than  
5 Timer\_Status\_Prohibit (retransmission request transmission time) that is the time elapsed between the time the communication terminal apparatus requests retransmission and the time the communication terminal apparatus requests again retransmission when  
10 retransmitted transmission packet data retransmission of which was requested cannot be received. In addition, the operation in the communication system for performing communications using base station apparatus 100, communication terminal apparatuses 200 and the like is  
15 the same as in FIG. 9, and descriptions thereof are omitted.

Thus, in addition to the advantage of Embodiment 1, according to Embodiment 2, the amount of storage in the buffer is controlled for both transmission packet data requested for retransmission and new transmission  
20 packet data not requested for retransmission such that the queuing delay time of the transmission packet data retransmission of which is requested stays above the value of Timer\_Status\_Prohibit, thereby making it possible to dependably reduce the number of retransmission requests.

25

(Embodiment 3)

FIG. 12 is a block diagram illustrating a

configuration of base station apparatus 900 according to Embodiment 3 of the invention. As shown in FIG.12, base station apparatus 900 according to Embodiment 3 has separating section 901, and retransmission packet buffer 902 and new packet buffer 903 as a substitute for buffer 107 in base station apparatus 100 according to Embodiment 1 as shown in FIG.4. In addition, in FIG.12, the same structural elements as in FIG.4 are assigned same reference numerals to omit descriptions thereof. A configuration of a communication terminal apparatus is the same as that in FIG.5, and descriptions thereof are omitted.

Scheduler 104 holds a reference table storing modulation scheme information that associates a modulation scheme such as 16QAM with CQI, and another reference table storing coding rate information that associates a coding rate with CQI. Each of the base station and communication terminal apparatuses has the same reference table storing the modulation scheme information and the same reference table storing the coding rate information. Then, scheduler 104 refers to the reference tables using the CQI input from CQI extracting section 103, thereby determines transmission parameters such as a modulation scheme and coding rate, and further determines a communication terminal apparatus to which packet data is transmitted on a predetermined time basis. Scheduler 104 outputs thus determined

scheduling information of transmission parameters and the like to retransmission packet buffer 902, new packet buffer 903 and radio layer 1 processing section 102. At this point, scheduler 104 performs scheduling such that  
5 transmission packet data, retransmission of which is requested, stored in retransmission packet buffer 902 is output to radio layer 1 processing section 102 with a higher priority than new transmission packet data stored in new packet buffer 903.

10 Separating section 901 separates the transmission packet data retransmission of which is requested and new transmission packet data input from MAC-d processing section 105, and outputs the transmission packet data retransmission of which is requested to retransmission  
15 packet buffer 902, while further outputting the new transmission packet data to new packet buffer 903.

Retransmission packet buffer 902 temporarily stores the transmission packet data, retransmission of which is requested, input from separating section 901, and  
20 outputs transmission packet data of timing and the amount of data corresponding to the result of scheduling in scheduling section 104 to radio layer 1 processing section 102. Further, retransmission packet buffer 902 is set for an upper limit threshold and lower limit threshold  
25 to compare with a amount of data stored of transmission packet data, and outputs the result of comparison between the amount of data stored and the upper limit threshold

or between the amount of data stored and the lower limit threshold to HS-DSCH/FP processing section 108 as the amount of data stored information.

New packet buffer 903 temporarily stores the new  
5 transmission packet data input from separating section 901, and outputs transmission packet data of timing and the amount of data corresponding to a result of the scheduling in scheduling section 104 to radio layer 1 processing section 102. Further, new packet buffer 903  
10 is set for an upper limit threshold and lower limit threshold to compare with a amount of data stored of new transmission packet data, and outputs a result of comparison between the amount of data stored and the upper limit threshold or between the amount of data stored and  
15 the lower limit threshold to HS-DSCH/FP processing section 108 as the amount of data stored information.

Referring to FIG.13, described below is the operation in the communication system for performing communications using base station apparatus 900, mobile  
20 terminal apparatuses 200 and the like. FIG.13 is an operation sequence diagram illustrating the operation in the communication system for performing communications using base station apparatus 900, mobile terminal apparatuses 200 and the like. In addition, in FIG.13,  
25 retransmission packet buffer 902, new packet buffer 903, HS-DSCH/FP processing section 108 and RLC processing section 106 in the base station apparatus are provided

in the same base station apparatus 900.

First, when HS-DSCH/FP processing section 108 in base station apparatus 900 confirms that the amount of data stored in retransmission packet buffer 902 and the amount of data stored in new packet buffer 903 of MAC-hs processing section 109 are less than or equal to the set lower limit threshold (the number of AMD-PDUs is "2"), HS-DSCH/FP processing section 108 outputs a capacity allocation message to permit transmission of new AMD-PDU to RLC processing section 106 (step ST1001). In addition, it is assumed in FIG.13 that "4" is the maximum number of AMD-PDUs that can be transmitted within one transmission period T on the radio channel. However, the maximum number of AMD-PDUs that can be transmitted within one transmission period T is not limited to "4", and may be set at an arbitrary number..

RLC processing section 106 of base station apparatus 900, to which the number of AMD-PDUs allowed to be newly transmitted is reported, outputs to new packet buffer 903 four AMD-PDUs 0~3, (step ST1002). At this point, since transmission packet data to retransmit does not exist because a retransmission request is not transmitted from communication terminal apparatus 200, all the transmission packet data is stored in new packet buffer 903. Then, the amount of data stored in new packet buffer 903 becomes more than or equal to the upper limit threshold (the number of AMD-PDUs is "4"), and HS-DSCH/FP processing



section 108 instructs RLC processing section 106 to halt transmission.

MAC-hs processing section 109 fetches AMD-PDUs0,1 from new packet buffer 903 by instruction from scheduler  
5 104 to transmit to communication terminal apparatus 200 (step ST1003).

At this point, AMD-PDU0 is discarded that is one of two AMD-PDUs transmitted due to an error on the radio channel. In addition, in the case of HSDPA, an AMD-PDU  
10 targeted for discarding at this point is not saved even by performing retransmission by HARQ.

RLC processing section 205 in communication terminal apparatus 200 transmits STATUS-PDU0 set for a retransmission request for the discarded AMD-PDU0 to RLC  
15 processing section 106 in base station apparatus 900 (step ST1004). However, at this point, RLC processing section 106 does not have permission to transmit a new AMD-PDU, and does not transmit AMD-PDU0 requested to retransmit.

Next, since the amount of data stored in  
20 retransmission packet buffer 902 and the amount of data stored in new packet buffer 903 are less than or equal to the lower limit threshold, HS-DSCH/FP processing section 108 in base station apparatus 900 permits RLC processing section 106 to newly transmit two AMD-PDUs  
25 in consideration of the receivable data amount in communication terminal apparatus 200 (step ST1005).

RLC processing section 106, the number AMD-PDUs

allowed to be newly transmitted is reported, outputs AMD-PDU0 retransmission of which is retransmitted and new different AMD-PDU4. Then, separating section 901 outputs AMD-PDU0 retransmission of which is retransmitted  
5 to retransmission packet buffer 902, and retransmission packet buffer 902 stores AMD-PDU0. Further, separating section 901 outputs new transmission packet data AMD-PDU4 to new packet buffer 903, and new packet buffer 903 stores AMD-PDU4 (step ST1006).

10 Next, scheduler 104 causes the transmission packet data requested for retransmission and stored in retransmission packet buffer 902 to be preferentially output and transmitted to communication terminal apparatus 200 (step ST1007), and then, causes AMD-PDUs 2, 3  
15 that cannot be transmitted before retransmission is requested to be output and transmitted to communication terminal apparatus 200 (step ST1008).

Thus, in addition to the advantage of Embodiment 1, according to Embodiment 3, transmission packet data requested for retransmission and new transmission packet  
20 data are separately stored, thus making it possible to always transmit the transmission packet data requested for retransmission earlier and reduce the delay of the transmission packet data requested for retransmission.

25 In addition, in Embodiment 3, HS-DSCH/FP processing section 108 may control the number of AMD-PDUs using the amount of data stored in retransmission packet buffer

902, the amount of data stored in new packet buffer 903, and the receivable data amount of communication terminal apparatus 200, as in Embodiment 1, or HS-DSCH/FP processing section 108 may control the number of AMD-PDUs  
5 using the amount of data stored in retransmission packet buffer 902, the amount of data stored in new packet buffer 903, and queuing delay time, as in Embodiment 2.

With Embodiments 1 to 3, it may be possible to implement the operation process of the base station  
10 apparatus and transmission method with a computer program and execute the computer program on a computer. Further, it may be possible to store the computer program implementing the operation process of the base station apparatus and transmission method in a storage medium  
15 such as CD-ROM and DVD, or transmit the computer program implementing the operation process of the base station apparatus and transmission method to a computer using an electric communication channel and execute the transmitted computer program using the  
20 transmission-destination computer.

As described above, according to the present invention, by controlling the amount of transmission packet data requested for retransmission stored in a buffer, it is possible to reduce the number of  
25 retransmissions, improve throughput, and prevent disruption in communication and channel disconnection.

This application is based on Japanese Patent

Application No.2003-276974, filed on July 18, 2003, the entire content of which is expressly incorporated by reference herein.

5 Industrial Applicability

The present invention relates to a base station apparatus and transmission method, and is particularly suitable for use in a base station apparatus and transmission method using an automatic repeat request  
10 system to recover a loss of a packet on a radio channel by retransmission of the packet.